



Michigan Department of Transportation

Line of Business Strategy for Vehicle-Infrastructure Integration Part II: Specific Goals and Activities

Vision of
Partnership and
National Leadership

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Title

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Vehicle-Infrastructure Integration
Line of Business Strategy for
Vehicle Infrastructure Integration

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Abstract

Part II of the Line of Business Strategy expands on Part I of the Michigan Department of Transportation's (MDOT's) Vehicle Infrastructure Integration (VII) Strategic and Business Plan by providing details on customer needs, goals, and specific activities for addressing these needs and accomplishing the goals. Furthermore, Part II of the strategy shows how the work activities align with and the strategic outcomes/goals that clearly support customer and partnership needs for Vehicle Infrastructure Integration. These goals and activities are derived from MDOT's VII mission, vision, and goals that are described in greater detail in Part I of the VII Strategic Plan document.

This plan initiates a course of action toward establishing the required public- and private-sector partnerships that will ensure leadership, innovation, and progress across the State of Michigan. The strategy focuses on partnering, developing and deploying a VII infrastructure and testbeds; increasing safety and mobility; improving asset management; developing outreach programs to better expose others to VII in Michigan; justifying the need for VII; and determining creative investment funding venues for VII activities.

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EXECUTIVE SUMMARY

Michigan's Line of Business (LOB) Strategy for Vehicle-Infrastructure Integration (VII) expands on Michigan Department of Transportation's (MDOT) VII Strategic Plan by providing details on customer and partner needs, activity fits or outcomes/goals, and specific activities for accomplishing the goals. The strategy shows clear and distinct alignment between specific activities and outcomes/goals that clearly support customer needs and the strategic intent. These goals and activities are derived from MDOT's VII mission, vision, and goals that are described in greater detail in Part I of the VII Strategic Plan document. The goals and activities are organized into the following strategy categories that are the basis for the organization of this document:

- Partnership Strategy
- Infostructure Deployment Strategy
- Test Bed Strategy
- Safety Strategy
- Traffic Management Strategy
- Asset Management Strategy
- Outreach Strategy
- Justification Strategy
- Investment Strategy

MDOT will review the VII strategy periodically to assure that progress is being made toward achieving the goals and that the plan remains consistent with events in the technology and political environment that can potentially influence the relevance and effectiveness of the strategy. Progress will be monitored, measured, and evaluated to assure that the goals are being accomplished effectively and on time and on budget. A critical initial activity is to encourage review and obtain input of the overall plan from key representatives of the customers and partners. This is an urgent strategic activity that MDOT is already engaged in.

The specific strategic and tactical measures of success referenced to each of the activities are listed on page 19. These also will be refined and updated as the continuous planning process proceeds. Again, success at the activity level will ensure that the strategy is implemented and that the goals are achieved. MDOT's strategy for VII is succinctly summarized in Figure 1. The schematic provides a visual representation of strategic elements and interrelationships including the customers/partners and their needs, goals, and activities, as well as measures that will be taken in the next five years to achieve the VII mission and vision. Furthermore, the strategic plan shows the alignment and support between goals and needs that stand on a strong foundation of activities necessary to develop lasting partnerships. Increased safety, more efficient mobility, and economic development are the chief end products for MDOT's pursuit of VII.

MDOT'S LINE OF BUSINESS STRATEGY FOR VII

The following strategy takes the Part I of the Michigan Vehicle Infrastructure Integration Strategic Plan as a starting point and elaborates on the goals and specific activities needed to accomplish the goals in a specified time-frame. Note that in this plan VII is not limited to medium range roadside communication standards like Dedicated Short Range Communication (DSRC) or Wi-Fi. Rather, the Michigan strategy is to be open to all potential mobile communication pipelines ranging from medium-range to long-range mobile communication pipelines like advanced cellular and satellite technologies. The intent is to innovate and to bridge the needs of the stakeholders in the automotive, telecommunications, and transportation industries with cost-effective and sustainable solutions that improve safety and mobility.

The needs and issues addressed by wireless vehicle communications systems are then summarized in the Vehicle Infrastructure Integration (VII) mission. MDOT's VII Mission is to:

Partner with public agencies, the automotive industry, and the telecommunications industry to lead the nation in VII research and sustained VII deployment by providing the public foundation for Michigan's new automotive information technology industry and ensuring improvements in transportation systems safety and operational performance.

Again we start with the vision for Vehicle Infrastructure Integration. MDOT's Vision for Vehicle Infrastructure Integration (VII) emphasizes partnership and leadership. In this vision MDOT is a public leader and supporting partner in the research, development, deployment, operation, and maintenance of VII. MDOT's VII vision is:

- ***The Michigan partnership is a recognized leader of and key reason for the success of VII.***
- ***Michigan is partnering with the automotive industry, including OEMs and suppliers, and the telecommunications industry, and has demonstrated success in researching, developing, and deploying VII.***
- ***Michigan is partnering with other states to assure coordinated research, development and deployment across the United States.***
- ***VII test results provide clear measurable evidence that VII increases transportation safety, mobility, and security.***
- ***VII has been accepted enough to be programmed into the annual budgeting of Michigan's transportation needs.***
- ***VII has become an emerging industry with an entrepreneurial foundation that is central to Michigan's strong new information technology sector.***
- ***VII is becoming acknowledged as the biggest change in passenger and commercial transportation since the inception of the Interstate Highway System.***

MDOT has a wide range of potential customers and partners for VII. The term customer is meant to imply that MDOT provides products and services to users of the transportation system

and that the system has economic and mobility benefits beyond the everyday commuter and other drivers that use the system. In this context, the concept of customer is any individual or organization that will use, benefit from, and/or pay taxes for Michigan's VII. Similarly, the delivery of VII products and services will require partnering with many of MDOT's customers and benefit stakeholders, many of whom will gain by designing and offering products and services that the new market in VII will support. Some of MDOT's potential customers and partners include:

- Motorists
- Commercial fleets
- Local agencies (local and regional transportation agencies)
- USDOT
- Automotive OEMs
- Automotive suppliers (including telematics)
- Universities; and
- Other states

The customers and partners are the primary drivers of MDOT's VII strategy. The customer's long-term use of the products and services supported by MDOT and MDOT's partners will determine the viability and sustainability of VII and the ultimate success of this strategy.

MDOT's customers and partners for VII have needs that must be addressed in the VII strategy if it is to be successful. It is MDOT's role to deliver on the products and services that support these needs in the most competitive and cost effective manner. The customer and partner needs in the VII strategy are:

- **Growing Sustainable Deployment:** Research and testing of VII is just a start. The intent is to initiate and sustain the deployment of a standard ubiquitous national VII infostructure along with evidence providing justification and political support for state and national VII deployment.
- **State-of-the-art Test Facilities:** State of the art VII test and development facilities and competencies is core to advancing VII especially from the perspectives of the OEMs, automotive suppliers, telematics providers, and Michigan universities.
- **Asset Management:** Data and analysis of Michigan's transportation assets and infostructure are required if transportation assets are to be managed effectively.
- **Traffic Management:** Well managed traffic and efficient travel with minimum congestion and delay is needed by the motorists, commercial fleet, local transportation agencies and the USDOT to name a few.
- **Safety:** Safer travel along Michigan roads includes reducing the number and severity of vehicle crashes, related property damage and productivity losses, and related delay by increasing the overall safety of equipped vehicles.
- **Economic Development:** Growth in VII-related jobs and a strong Michigan economy is a core need for all customers and partners. The economic development goal for VII is for

MDOT to facilitate collaboration and to work with all the parties that will be involved in the design and deployment of VII in Michigan and contribute to the emergence of a new industry that will create and attract new jobs to the state.

- **Leadership:** National leadership and coordination for advancing VII quality, performance, and national deployment is a unique role that Michigan can play.
- **Financial Support:** Financial support for advancing research and development in VII (preferably supplemental to Michigan's tax base) is essential, given the need to advance the state of the art and practice in wireless technology for vehicle infrastructure integration.
- **Cost-effectiveness:** Provide effective infrastructure, infostructure, products, and services at the lowest cost.

Note that the customer and partnership needs are similar to, yet distinct from, the strategic goals. This is clarified in Figure 1 that shows the relationships between customers/partners, the associated needs, and the derived goals.

Strategic Goals as Activity Fits

The MDOT VII strategy is to address the customer needs and be the leader in the development and implementation of wireless technology for vehicle infrastructure integration to improve safety, mobility, economic development, and asset management while securing and sustaining partnerships that leverage resources to support the mission for economic benefit and improved quality of life. This will be accomplished through the VII line of business that addresses the needs of partners and customers through the support of wireless transportation innovation and technology linking vehicles to the infrastructure and other vehicles.

Several strategic goals will help set MDOT's sights on taking the appropriate actions to address these needs. These goals can be viewed as "activity fits", defined as a group of activities that "fit together" or are aligned to achieve a desired outcome. To provide feedback on performance, goals will be measurable and relevant changes will be implemented to continually improve the strategic alignment between goals and activities. The following are MDOT's strategic goals for the VII line-of-business:

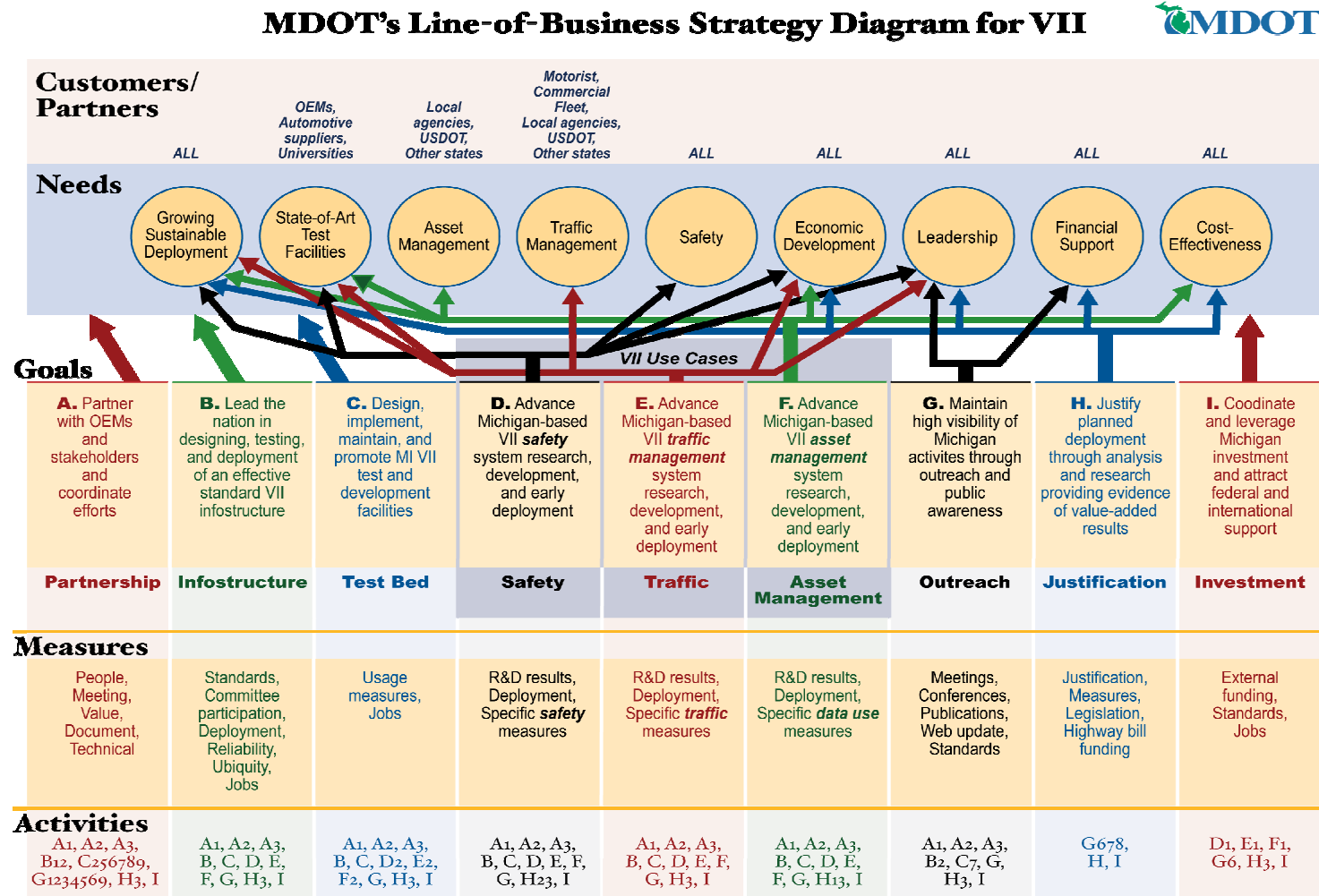
- **Partnership:** Partner with OEMs and other stakeholders that are essential to developing and delivering a national VII.
- **Infostructure:** Lead the nation in the design, testing, and deployment of an effective standard VII infostructure.
- **Test Bed:** Design, implement, maintain, and promote Michigan VII test and development facilities.
- **Safety:** Support Michigan-based VII safety system research, development, and early deployment; to reduce crashes and delay while increasing the safety of equipped vehicles.
- **Traffic Management:** Support Michigan-based VII traffic management system research, development, and early deployment; to reduce delay and relieve congestion.

VII will help improve the traffic operations and infrastructure investment by helping to collect better planning data and providing better information that will help manage throughput and capacity.

- **Asset Management:** Support Michigan-based VII asset management system research, development, and early deployment; to improve cost-effective investment in Michigan's transportation infrastructure and the VII infrastructure. Part of this strategy includes collecting vehicle probe data and thereby reducing the cost of data collection for delivering planning and asset management services.
- **Outreach:** Maintain high visibility of Michigan activities through strategic outreach and public awareness activities; coordinate and share information with stakeholders and other states to increase the rate and success of the national VII deployment.
- **Justification:** Justify planned research, development, and deployment through analysis and research providing evidence of value-added results; produce research, test results, and analysis that provide the justification for Michigan and national VII deployment.
- **Investment:** Coordinate and leverage Michigan investment to attract public, private, national, and international support; attract national and international investment in VII testing, products, and services.

The activities that will be pursued by MDOT in the VII line-of-business will be measured and evaluated to assure that the needs are being met and the goals are being achieved in a reasonable timeframe. The specific strategic and tactical measures referenced to each of the activities that follow are listed on page 19. Success at the activity level will ensure that the strategy is implemented and that the goals are achieved.

FIGURE 1: MDOT'S LINE OF BUSINESS STRATEGY DIAGRAM FOR VII



Partnership Strategy

MDOT's goal includes partnering with organizations from the automotive, telecommunications, and consumer electronics industries, coordinating with other public agencies, and working together with these partners in the design, testing, deployment, and long-term maintenance and support of the VII system.

Stakeholders from the automotive industry, telecommunications industry, and public transportation agencies will contribute to the design and deployment of VII to reflect an integrated transportation system perspective of vehicle and infrastructure design. Given the complimentary roles in support of transportation by the public and private sectors, addressing these higher order effects requires cooperation and action from both sectors. Only by working in partnership can they address the environmental, health, and safety impacts of the transportation system; ensure that the transportation network remains conducive for economic development; and assure that mobility improvements are sustainable in the future. Both sectors will benefit from sustainable mobility that supports the movement of people and goods in a safe and environmentally sound manner.

From the perspective of the automotive industry it is essential for all states to participate and to ensure that the communications infrastructure and traffic information will be provided consistently across the United States; from the perspective of the 50 states it is essential for all the auto companies and the entire automotive industry to participate and ensure that all in-vehicle traffic information systems will comply with a standard delivery approach adopted by the states.

For the telematics industry, this initiative may provide the needed impetus to rally the industry to a single expert test environment for a more focused telematics systems development, services development, and field operational testing. The plan is to accelerate the roll out of VII products and services that will increase the U.S. telematics market and serve as the standard for nationwide system deployment.

In order to manage VII from a full systems perspective, MDOT will need to collaborate with a broad range of organizations that will contribute to the design, testing, deployment, and long term maintenance of the integrated system. MDOT will need to develop and maintain new relationships with companies from the automotive industry (including the OEMs and automotive suppliers) who will be responsible for developing in-vehicle systems. MDOT will also need to pursue new relationships with companies in the telecommunications and consumer electronics industry that will be responsible for developing mobile devices and communications technologies. Finally, MDOT will need to coordinate and partner with departments within the state and public agencies that will be responsible for other portions of the system, including traffic signals on local surface streets and emergency and maintenance operations.

MDOT's partnership strategy for VII has the following objectives:

- Open new dialogues between MDOT and the automakers on multiple issues (not just VII).
- Participate actively with the telecommunications industry in supporting the infostructure for developing an environment that actively encourages innovative and sustainable mobility.
- Work with other states in the development and testing of VII to ensure that systems function in all conditions and geographic locations.

The subsequent activities comprise the partnership strategies that support the public and private collaborative goals for VII described in this section including partnerships and public outreach:¹

Michigan Transportation Partnership (A1 in Figure 1)²

At the forefront of the MDOT VII strategy is the creation of an executive level partnership between the State of Michigan and its automotive Original Equipment Manufacturers (OEM). Such a partnership could potentially include Chrysler, Ford, General Motors, Hyundai, Nissan, and Toyota. All have a major presence in the state. The purpose of this partnership will be to provide a high level strategic approach to addressing new opportunities for transportation innovation and economic development in the State of Michigan. The MDOT VII strategic goal is to partner and coordinate activities with OEM's and stakeholders.

The creation of this partnership alone is significant. In no other venue does senior management in the State of Michigan meet with all of the State's automotive OEMs to discuss the opportunities for transportation innovation, economic development, and sustainable mobility.

Fundamentally, it is essential that the automotive industry remain a viable industrial cluster in the State of Michigan. This strategic alliance will focus on technology-based innovation and support for new OEM business models that advance VII technologies into the marketplace more cost effectively and expeditiously.

To get the Michigan Transportation Partnership activities underway and to ensure a sustainable commitment among the partners to a joint effort that provides value to both the state and the companies, the following activities will be pursued:

1. Form Michigan Transportation Partnership (MTP) with automotive OEMs. (1, 2) 06, 07, 08+

¹ Each activity is followed by a reference to the activity measures (see page 19 for Measures of Success) in parentheses and the year the activity will be started, i.e., 07 for 2007 and 08+ for 2008 and the following years.

² The letter and the number in parentheses in the strategy section titles assist with referencing the activities listed in Figure 1 (MDOT Line-of-Business for VII). Groups of activities support each goal in the MDOT Line-of-Business for VII.

2. Hold an annual workshop and summit at the Management Briefing Seminar (MBS) (1, 2, 3) 06+
3. Hold semi-annual meetings of the MTP (1, 2, 3) 06+
4. Review MDOT VII program and projects annually (4) 07+
5. Review and update MDOT's VII strategic plan (4) 06+
6. Coordinate state, regional, and national deployment strategies with automotive companies and national deployment plans. (See B2) (1, 4) 07+
7. Expert survey and forecast integrated systems and technologies to help target partnership needs and opportunities (1, 4) 06+
8. Survey best practices and formulate new VII business models that support innovation and partnership opportunities (1, 4) 07+

Michigan VII Working Group (A2 in Figure 1)

MDOT will establish a VII working group that will hold regular working meetings with automotive suppliers, telecommunications, and consumer electronic companies.

1. Establish a Michigan VII Working Group to meet periodically to share information, coordinate activities, and monitor progress on test bed, proof of concept, Connected Vehicle Proving Center, field operational test, and Michigan deployment planning activities. (1, 2) 06
2. Enable representation from the VII Working Group in the MTP meetings with OEMs and coordinate meetings to provide timely input and feedback to the OEM partnership. (1, 2, 4) 06+
3. Develop plans for Proof of Concept (POC), Field Operational Test (FOT), Proving Center, and allied Michigan Test Bed activities with automotive OEMs, automotive suppliers, telecommunications, and consumer electronics input. [See C#2, #6, #7] (1, 4) 06+
4. Coordinate and monitor VII Working Group task assignments and progress. (4) 06+
5. Work with the VII-C to select Proof of Concept tasks and coordinate these tasks with the Michigan Test Bed planning and deployment. [See C] (1, 2, 4) 06+
6. Develop work plans for the Michigan Test Bed that complement the VII-C and other stakeholder initiatives and enable the Test Bed to incorporate the VII-C findings. [See C#5, #6] (4, 5) 07+

7. Assist the MTP with developing a state and regional deployment plan based on the national VII deployment plan. (See B2) (1, 2, 4, 5) 07+
8. Hold internal meetings with MDOT staff to stay abreast of progress and recent developments. (1, 2, 3, 4, 30, 31) 08+

Inter-State Partnership (A3 in Figure 1)

MDOT will establish partnerships with lead VII states in coordination with conference opportunities to share progress and create opportunities for coordinated research and eventually cross-state deployment expansion.

1. Correspond with other states expanding their VII development including extending invitations for other states to participate in the Michigan program. (1, 2, 4) 06+
2. Maintain a leadership role on AASHTO's VII committees. (2) 06+
3. Maintain a leadership role on the VII Executive Leadership Team (ELT). (2) 06+
4. Continue with Michigan's participation and involvement in the USDOT's VII National Working group. (2) 06+
5. Escalate Michigan's involvement in the SmartHighway program that includes Florida, California, Minnesota, and other possible states. (1, 2, 3, 4) 06+
6. Expand Michigan's involvement in regional corridor programs including the Transportation Operations Partnership (TOP) Forum and the Gary-Chicago-Milwaukee (GCM) with the intent of regional VII deployment expansion. (2) 06+

Infostructure Deployment Strategy (B in Figure 1)

With the completion of the interstate highway system, increasing congestion, and growing limits to highway expansion has become more important for MDOT to improve the operations of the road transportation systems to make the most of investments in transportation infrastructure assets. The VII infostructure strategic goal is to lead the nation in the designing, testing, and deployment of an effective standard VII infostructure.

MDOT has been working with the automotive, telecommunications and consumer electronics companies to collectively design, test, and deploy a wireless infrastructure on Michigan roads. This investment will enable vehicles to communicate with the roadside and exchange messages in real time to improve vehicle safety and to provide transportation services inside the vehicle and to our traffic management centers.

MDOT's efforts in this area are at a critical turning point. The USDOT plans to develop and test this new technology to prove the concept, and to demonstrate the potential benefits of a national deployment scheduled for a viability assessment decision to move forward on national deployment. Federal support will advance Michigan's position toward this objective. However, even without external support Michigan intends to move forward through local investment and partnerships.

The following activities will assure that MDOT leads the nation in design, testing and deploying an effect standard VII national infostructure:

1. Contribute to the deployment discussions of the national VII Working Group and Executive Leadership Team [See A3 #3, #4] (2) 07+
2. Prepare a State of Michigan VII Deployment plan that coordinates Michigan's deployment with national expansion. [See A1 #6 and A2 #7] (1, 4, 5) 07
3. Leverage the Michigan and Midwest field operational test with plans for national deployment. Include Midwest regional deployment in the Michigan VII Deployment Plan. (1, 4, 5) 07
4. Deploy VII infostructure according to plans and in coordination with the VII-C POC and FOT, USDOT national deployment plan, and standards committees. (1, 7, 16, 23) 09+

Test Bed Strategy (*C in Figure 1*)

The test bed strategy will focus mostly on process in the short run and safety and mobility objectives in the long run. While it is unlikely that the system design and testing phases of the VII program will have much (if any) impact on mobility and safety, it will be through proof of the concept, proving center developments, and operational testing and evaluation that VII will reach readiness for deployment of a public infrastructure and the sale of new mobile products and services. Therefore, involvement with and successful completion of proof of concept, field testing, the system evaluation processes and activities will provide the measure for the goals of safety and mobility. MDOT's goal is to design, implement, maintain, and promote Michigan VII test and development facilities.

MDOT will initiate and implement Michigan's VII Test Bed to deploy sustainable VII infrastructure, support the VII-C's POC projects, and create an environment for FOTs and eventual sustained deployment of VII in Michigan and across the nation. The design and deployment of a self-supporting infrastructure will provide value without respect to the success of VII and will provide continued value even if the VII decision is no-go in 2008. MDOT will pursue the following activities to implement-the test bed goal:

1. Design a self-supporting test bed infostructure, including data collection server and analysis tools, which will provide continued value even if the VII decision is no-go in 2008. See specific use cases (DEF) for details. (4, 5, 6, 16, 23) 06+
2. Prepare test bed plan with the partners. [A2 #3] (1, 2, 5, 17) 06+
3. Deploy test bed infrastructure as planned. (5, 6, 7, 8, 9, 16) 06+
4. Evaluate the technical and functional operation of the test bed infrastructure including data communication, signal availability, and networking. [See A2 #1] (5, 6, 7, 8, 9, 16) 07
5. Evaluate the benefits and costs of asset management, traffic management, safety, and other use cases, taking advantage of the OEM leased vehicles, and assessing the impact on MDOT and other public and private organizations. [See D, E, and F for more details.] (9, 10, 11, 14) 07
6. Work with the automotive companies and the VII-C to design successful POC projects and “Field Trials” that will eventually integrate into test bed and later support Michigan’s state and national VII deployment plan. [A2#5, #6] (1, 2, 5, 7, 16) 06+
7. Design the test bed to coordinate with the Connected Vehicle Proving Center, Cooperative Intersection Collision Avoidance Systems, IVBSS, and other projects supported by Crash Avoidance Metrics Partnership (CAMP) with Cooperative Intersection Collision Avoidance Systems (CICAS) project, University of Michigan Transportation Research Institute and other state research organization like Michigan State University and University of Detroit Mercy. [A2#6] (1, 5) 06+
8. Operate, manage, staff, and maintain test bed and make it available for use with continuous operation and functionality. (7, 9, 11, 15) 06+
9. Provide training and support for use of the test bed. (11) 07+

Safety Strategy (*D in Figure 1*)

Safety is the primary goal that is shared by automotive companies and transportation agencies. There were 1,159 persons killed and 99,680 persons injured in 373,028 reported motor vehicle traffic crashes in Michigan during 2004. The safety objectives will not advance significantly until there is significant deployment of the telecommunications infostructure and until drivers purchase vehicles that support the consumer electronics that complete the safety and mobility applications. Nevertheless, VII presents an opportunity to save hundreds of Michigan lives and to prevent even more injuries, property damage and related productivity loss through improvements such as:

- Prevent crashes and reduce their severity at intersections by providing traffic monitoring, detecting dangerous situations, warning drivers, and possibly even controlling signals and vehicle behavior.
- Warn drivers to reduce speeds at curves and work zones as well as dangerous and unintended lane departures
- Increase driver awareness by providing warnings for: school zones, hazardous road conditions, low overhead (i.e., bridge, parking garage, storage), wrong way, and other potentially dangerous road features.

Crash prevention and reduction in severity will be essential measures for evaluating the potential benefit of VII use cases that will be designed, tested, and deployed in Michigan. While there will be little actual improvement in safety during the system design and test phases, the candidate user applications will nevertheless be studied and evaluated for their potential future contribution to improved driver safety. MDOT's goal is to advance Michigan-based VII safety system research, development, and early deployment to reduce accidents and delay while increasing the safety of equipped vehicles.

The other high priority category of use cases is safety warning systems. In-vehicle warning systems are primarily designed to increase motorist safety by providing in-vehicle warnings at selected road features like dangerous curves and intersections. These generally involve short-range vehicle-to-infrastructure and infrastructure-to-vehicle communication to inform the roadside of vehicle behaviors and to warn drivers of impending conditions.

One of the real opportunities provided by VII to road transportation agencies is increasing the protection for drivers and workers around work zones. Work zone notifications related to driver warnings are high priority applications for MDOT. MDOT has continuing interest in most in-vehicle signage systems including road advisories and local notifications. The specific activities to support this goal are listed below:

1. Research and develop use cases, possibly participating in pooled fund study with other states, in the following areas:
 - Active collision avoidance (17, 18, 19, 26) 08+
 - Passive hazard warnings (17, 18, 19, 26) 08+
 - In-vehicle signing (17, 18, 19, 26) 07+
 - Work and school zone notification (17, 18, 19, 26) 07+
 - Identify roadway design deficiencies (17, 18, 19, 22, 26) 09
2. Plan, design, and validate roadside equipment and back-office applications that will support these use cases. [See C1 and B4] (7, 8, 16, 23) 07+

Traffic Management Strategy (*E in Figure 1*)

The goal is to advance Michigan-based VII traffic management system research, development, and early deployment to improve the mobility of Michigan drivers and their access to information about destinations and travel choices. This includes increasing traffic efficiency to help drivers save time and money by providing alternate routes in response to traffic incidents. VII will provide probe data and infrastructure management tools for both operators and users of the transportation system. The probe data will assure comprehensive coverage by including all roads, jurisdictions, and (eventually) all vehicles. It will increase mobility, accessibility and traffic efficiency by making improvements such as:

- Inform drivers and re-route traffic around construction, work zones, accidents, or planned special events, using information from the vehicle probe data.
- Increase throughput by smoothing the flow of traffic through signals using vehicle probe data to re-time signals and/or control signals dynamically through real time traffic counts.
- Relieve congestion by detecting vehicles to improve the responsiveness of traffic signals and ramp metering.
- Improve transportation modeling, forecasting, and planning by obtaining more detailed data from probe vehicles.
- Sharing vehicle probe data regarding roadway hazards (such as cracks and potholes, road weather problems, or even sight distance and design problems) with traffic operations centers and traffic planning departments.
- Improve the management of road transportation assets by monitoring the network for pavement, bridge and other infrastructure conditions including assistance with sign inventories.

Probe applications are one of the highest priority categories of user services for MDOT because construction, maintenance, and operation of the state highways and surface streets are MDOT's primary lines of business. Data collected from vehicle probes will help MDOT plan for future road usage and possible expansion of facilities. It can be used to assess the appropriateness of investment in construction and maintenance, monitor maintenance needs like snow and ice removal and crack and pothole mapping. One of MDOT's chief objectives is to assess traffic patterns including origins, destinations, travel routes, traffic volumes, etc. to help plan for and maintain the road network.

Two-way in-vehicle communication systems are also of great value to MDOT because they provide a way to communicate information to drivers with little infrastructure investment to help relieve traffic congestion. These systems can help provide motorists information on incident, special event, & work zone alerts and bottleneck/congestion mapping. Because probes help detect traffic blockages, they assist with dynamic route guidance and navigation based on real time traffic information. Since the following use cases are addressed by the USDOT's "day one" plan for VII testing and deployment, the specific cases will be pursued in cooperation with other

states involved in the USDOT's national testing and deployment activities. The specific activities to support this goal are listed below:

1. Research and develop use cases, possibly participating in pooled fund study with other states, in the following areas:

Traveler Information Dissemination:

- En route accident/construction/event alerts (17, 20, 21, 26) 07+
- Real-time detour/reroute information (17, 20, 21, 26) 08+
- Tourism/commerce information (17, 24, 26) 07+
- Real-time multi-modal transfer information (10, 21, 26) 08+

Relieve Congestion:

- Traffic signal actuation and operations (17, 19, 20, 21, 26) 09+
- Work zones (17, 19, 20, 21, 26) 07+
- Ramp metering (17, 20, 21, 19, 26) 09+
- Improved traffic performance measurement and management (14, 17, 26) 07+

2. Plan, design, validate, and deploy (or acquire) roadside equipment and back-office applications that will support these use cases. [See C1 and B4] (7, 8, 16, 23) 07+

Asset Management Strategy (*F in Figure 1*)

The goal is to advance Michigan-based VII asset management system research, development, and early deployment. The probe applications offer access to data sources that will help MDOT assess and model transportation demand and traffic flows. Other VII data will help document pavement, bridge, and other infrastructure conditions, helping to reduce the cost of delivering these services. The plan for asset management is to collect data to determine if the service life of an existing asset has failed to meet the expected design life, achieved the expected design life, or exceeded it, and why. Another objective is to determine which assets have the biggest impact on the community. The specific activities to support this goal are listed below:

1. Research and develop use cases, possibly participating in a pooled fund study with other states, in the following areas:

Asset Management:

- Pavement (14, 25, 26) 08+
- Bridge (14, 25, 26) 08+
- Sign Inventories (14, 25, 26) 07+

Transportation Planning:

- Origin/Destination data (14, 25, 26) 08+
- Modeling (14, 25, 26) 09+
- Forecasting (14, 25, 26) 09+

Maintenance Programs:

- Snow/ice removal (14, 25, 26) 09+
- Pavement joint/crack and pot hole mapping dissemination (14, 25, 26) 08+
- Bridge deck monitoring (14, 26) 09+

2. Plan, design, validate, and deploy (or acquire) roadside equipment and back-office applications that will support these use cases. [See C1 and B4] (7, 8, 16, 23) 07+

Outreach Strategy (*G in Figure 1*)

MDOT will establish and support a public outreach program. The goal is to maintain high visibility of Michigan activities through outreach and public awareness. This activity will maintain MDOT's connection to other interest groups and to inform the public of the progress. The specific activities to support this goal are listed below:

1. Coordinate with Wireless Oakland and Washtenaw counties to address the interjurisdictional issues for managing roadside Dedicated Short Range Communication (commonly referred as DSRC) radios, Wi-Fi, WiMax, and mesh network deployment between sources and across jurisdictions. (1, 2, 13) 06+
2. Work with the Southeast Michigan Council of Governments (commonly referred as SEMCOG) to assure that VII is incorporated into the Michigan ITS Architecture and that the regional traffic operations organization takes VII cross-jurisdictional issues into account. (1, 2, 4, 7, 13) 07+
3. Plan presentations and report progress at ITS America, ITS Michigan, ITS World Congress, the Transportation Research Board (TRB), AASHTO, the Society of Automotive Engineers, Telematics Detroit, Management Briefing Seminar, and other conference and national outreach events. (1, 2, 4, 12, 13) 06+
4. Get Michigan staff in leadership roles on ITS America, TRB, and AASHTO committees. (1, 2, 27) 06+
5. Develop VII web site and a Michigan VII Newsletter that will be distributed monthly by mail. (4, 9, 10, 11, 24, 28) 06+

6. Establish working relationships with the Connected Vehicle Proving Center, Michigan universities, AASHTO, CVTA, ITS America (i.e., VII Task Force and Automotive Telecommunications & Consumer Electronics Forum), Center for Automotive Research, and ITS Michigan for ongoing discussions with stakeholders. (1, 29) 06+
7. Document and publish lessons learned to improve the state-of-the-art and practice in VII wireless communication. (4, 5, 11, 28) 07+
8. Develop and maintain a central repository of information on VII activities in State of Michigan. (11, 10, 24) 08+
9. Develop and maintain relationships with international transportation agencies. (1, 2) 06+

Justification Strategy (*H in Figure 1*)

VII will only be a success if MDOT can justify the start-up effort and sustained investment. The goal is to justify a planned deployment through analysis and research providing evidence of value-added results. Justification will rest on the industrial and economic development potential as well as the direct projected costs and benefits associated with an advantageous return on the investment of tax dollars. Therefore, it will be essential for MDOT to investigate the impacts of VII and engage the public in a dialogue based on sound facts and informed projections of the impacts. The specific activities to support this goal are listed below:

1. Prepare a study on the industrial and economic development potential for VII in Michigan to assure positive consequences of VII testing and deployment. (4, 5, 11) 06+
2. Investigate the potential for creating and/or attracting federal automotive safety facilities to Michigan. (4, 5, 11) 06+
3. Conduct a study of the projected benefits, cost and return on investment of VII for the State of Michigan and other partners. (1, 4, 11) 07+

Investment Strategy (*I in Figure 1*)

Successful investment in new technologies, programs, projects, hardware, software, infrastructure, and infostructure is essential to starting and sustaining VII. Therefore another goal for MDOT is to coordinate and leverage the Michigan investment and attracting federal and international support.

In addition to the pursuit of safety, mobility, sustainability, partnership, and economic development strategies that will define MDOT's effectiveness with regard to improving transportation and exercising a role in national leadership, MDOT also needs to address internal issues that will regulate the effectiveness toward this pursuit. Internal issues include the

alignment of MDOT's transportation mission and the VII strategy to the mission of other agencies with responsibilities for economic development and information technologies within the State of Michigan. The specific activities to support this goal are listed below:

1. Program VII into the annual budgeting of Michigan's transportation needs. Enter VII as a line-item in the State Transportation Improvement Plan and ensure that sufficient match monies are available. (1, 7, 25, 30) 07+
2. Investigate other sources of private sector and federal funding like Homeland Security, USDOT, etc. (1, 2, 7, 30) 06+
3. Coordinate with MEDC, the Michigan Department of Labor & Economic Growth, DIT, and MSP to seek grants for VII testing and deployment. (1, 2, 7, 25, 30) 06+
4. Invest in VII staffing to ensure that activities from the strategic plan are coordinated and completed. (1, 7, 23, 30, 31) 06+

MEASURES OF SUCCESS

The following measures are referenced by number following each of the activities listed in the VII strategy.

1. Get the right people involved
2. Did the right people meet?
3. Did the meeting have value and useful results?
4. Documented and completed
5. Technical value and merit*
6. Self supporting
7. Compliance with plans and timeline
8. Functional testing and validation*
9. Reliability (i.e., hardware, software)*
10. Ease of use in the human factors sense
11. Available to users
12. Participation/attendance
13. Make presentation
14. Benefits, costs, return-on-investment
15. Operational continuity
16. Compliance with technical standards (Identify standards to be met.)
17. Use OEM leased vehicles (number of vehicles in use)
18. Significant change in desired outcome (i.e., scientific comparison with before/after, and control groups)
19. Reduced number of traffic accidents and traffic-related injuries and fatalities by location and type
20. Total delay
21. Average travel time
22. Road quality (surface, structure, geometry)*
23. Within budget
24. Customer satisfaction (i.e., survey)
25. Community/public support (i.e., survey)
26. Data accuracy, reliability, and comprehensiveness*
27. Assigned to leadership role
28. Up-to-date and current content
29. Program involvement
30. Internal MDOT support
31. Work completion, staffing, capacity, resource coverage and use

*Measures with asterisks need further elaboration.

GLOSSARY OF TERMS

American Association of State Highway and Transportation Officials (AASHTO) - A nonprofit, nonpartisan association representing highway and transportation departments in the 50 states, the District of Columbia and Puerto Rico. The American Association of State Highway and Transportation Officials advocates transportation-related policies and provides technical services to support states in their efforts to efficiently and safely move people and goods.

Active Safety Systems - Active safety refers to everything designed to help prevent an accident from happening, such as, anti-lock braking system (ABS) and the traction control (ASR) to name a few.

Asset Management - Transportation asset management is a strategic approach to managing physical transportation infrastructure. Asset management promotes more effective resource allocation and utilization based upon quality information.

Crash Avoidance Metrics Partnership (CAMP) - A research partnership between Ford and GM that creates research consortia with other car manufacturers and their first-tier suppliers for crash avoidance research projects.

Center for Automotive Research (CAR) - Conducts industry research, develops new methodologies, forecasts industry trends, advises on public policy, and sponsors multi-stakeholder communication forums.

Cooperative Intersection Collision Avoidance Systems (CICAS) - Safety systems that have the potential to warn drivers about likely violations of traffic control devices and to help them maneuver through cross traffic safely.

Connected Vehicle Proving Center (CVPC) - A new proving center that supports the testing and evaluation of new products and services dedicated to improving vehicle safety and creating a pipeline for real-time broadband communication between vehicles, roadside transceivers, and remote service centers.

Connected Vehicle Trade Association (CVTA) - An association that enables the collaboration of companies, organizations, and government agencies engaged in developing vehicle communications.

Department of Transportation (DOT) - An organization responsible for transportation services in a political jurisdiction such as a State or city.

Dedicated Short Range Communication (DSRC) - A wireless (radio) communication approach that enables short-range communications between vehicles and between vehicles and the roadside for a variety of purposes, including cooperative safety.

Field Operational Test (FOT) - An operational testing and evaluation activity in which test subjects use products and systems in under conditions of conventional (or natural) use.

Global Positioning System Global Positioning System (GPS) - A worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations.

Infostructure - The intellectual content, facilities, information services, and technical systems provided in support of transportation communications by information resources and information technology.

In-Vehicle Based Safety Systems (IVBSS) - A USDOT program to develop and test systems that warn drivers when they may be about to leave the roadway, are in danger of colliding with another vehicle while attempting a lane change, or are at risk of colliding with the vehicle in front of them.

Line-of-Business - A logical way to conceptualize, develop and implement sustainable strategies at the line-of-business level.

Management Briefing Seminar (MBS) - An automotive industry conference in Traverse City every August. The 2007 Management Briefing Seminars will again take place at the Grand Traverse Resort and Spa Traverse City, Michigan, USA and the dates are August 6-10, 2007.

Michigan Transportation Partnership (MTP) - A strategic alliance between the State of Michigan and the automakers that will focus on technology-based innovation and support for new OEM business models that bring advanced auto technologies into the marketplace more cost effectively and expeditiously.

Original Equipment Manufacturer (OEM) - a term used to describe those companies that are the original manufacturers of vehicles and equipment.

Passive Safety Systems - Passive safety is a general term covering all design measures intended to protect the car's occupants against injury or to at least reduce the severity of injuries (examples include safety belts and airbags).

Proof of Concept (POC) - Product development activity that proves the viability and integrity of the engineering concept.

State Transportation Improvement Program (STIP) - A three-year program of all road and transit transportation projects to be undertaken with federal funds, required by ISTEA to be financially constrained, meet air quality conformity guidelines, and be consistent with the policies of the State Long Range Plan.

Testbed - A system representation consisting of vehicles, devices, and systems including actual hardware and/or software and computer models or prototype hardware and/or software for testing and evaluating a complete systems or components of a system.

Transceiver - A transmitter-receiver transmits and receives signals.

University of Michigan Transportation Research Institute (UMTRI) - A research institute at the University of Michigan that conducts interdisciplinary transportation-related research that will ultimately increase driving safety and further transportation-systems knowledge.

United States Department of Transportation (USDOT) - A Cabinet-level Department that exists to serve the United States by ensuring a fast, safe, efficient, accessible, and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future.

Use Cases - A use case is a description of a system that captures a goal-oriented set of interactions between external actors and the system under consideration.

Vehicle Infrastructure Integration (VII) - The application of wireless communication technologies to support mobile connectivity between vehicles and between vehicles and the roadside infrastructure.

Vehicle Infrastructure Integration Consortium (VII-C) - A Michigan nonprofit corporation founded in 2005 by group of light-duty vehicle manufacturers to design, test, and evaluate a deployable VII system for the United States.